Docket No. MR2533-16

PATENT APPLICATION TRANSMITTAL LETTER

TO THE COMMISSIONER OF PATENTS AND TRADEMARKS:
Transmitted herewith for filing is the Patent Application of
BOBBY HU

for
RATCHET WHEEL WITH ASYMMETRIC ARCUATE CONTOUR TEETH OR NON-ARCUATE CONCAVE TEETH AND RATCHETING TOOLS WITH SUCH RATCHET WHEEL

Enclosed are:

- [X] 26 sheets of drawings
- [ ] an assignment of the invention to
- [ ] a certified copy of a _____ application
- [ ] associate power of attorney
- [X] a verified statement to ascertain small entity status under 37 CFR § 1.9 & 1.27

CLAIMS AS FILED

	NUMBER FILED	NUMBER EXTRA	RATE	FEE
BASIC FEE			$760	$760
TOTAL CLAIMS	20-20	0	x 18	0
INDEPENDENT CLAIMS	6 -3	3	x 78	234
MULTIPLE DEPENDENT CLAIM PRESENT			$260	0
NUMBER EXTRA MUST BE ZERO OR LARGER			TOTAL	$994
If applicant is a small entity under 37 CFR 1.22, then reduce fee by 50%			SMALL ENTITY TOTAL	$497
ASSIGNMENT			$ 40	0
TOTAL PATENT APPLICATION FEE				$ 497

- [X] A check in the amount of $ 497.00 to cover the filing fee is enclosed.
- [X] The Commissioner is hereby authorized to charge and credit Deposit Account No. 18-2011 as described below. I have enclosed a duplicate copy of this sheet.
  - [ ] Charge the amount of $_____ as filing fee.
  - [X] Credit any overpayment.
  - [X] Charge any additional filing fees required under 37 CFR 1.17
    - [X] for this filing, and/or
    - [X] for later presentation of extra claims.
  - [ ] Charge any Patent Application processing fees under 37 CFR 1.17
    - [ ] for this filing only, or
    - [ ] during pendency of this Application
  - [ ] Charge the issue fee set in 37 CFR 1.18 at or before mailing of the Notice of Allowance, pursuant to 37 CFR 1.317(b).

8/2/99
Date

Signature

RATCHET WHEEL WITH ASYMMETRIC ARCUATE CONCAVE TEETH OR NON-ARCUATE CONCAVE TEETH AND RATCHETING TOOLS WITH SUCH RATCHET WHEEL

Background of the Invention

1. Field of the Invention

The present invention relates to a ratchet wheel with asymmetric arcuate concave teeth or non-arcuate concave teeth. The present invention also relates to a ratcheting tool, e.g., a ring spanner having a box end in which the ratchet wheel is mounted. The ratchet wheel with asymmetric arcuate concave teeth provides improved structural strength and improved torque. The ratchet wheel with non-arcuate concave teeth is easy to form and thus reduces the production cost.

2. Description of the Related Art

A wide variety of spanners and wrenches have heretofore been provided. Ring spanners are the best choice for driving fasteners (e.g., nuts, bolt heads, etc) in a limited space that is uneasy to access and difficult to operate all kinds of ratcheting tools. Nevertheless, conventional ring spanners have low driving torque. Ratchet type ring spanners have been proposed to solve this problem. A ratchet wheel is mounted in the box end of a ring spanner for driving fasteners at high torque. It is, however, found that, the structural strength of the ratchet wheel is weak, as an outer periphery of the ratchet wheel is processed to form a plurality of arcuate teeth with a considerable depth.

Figs. 11 through 13 of the drawings illustrate a conventional ratchet wheel 1 mounted in a box end (not shown) of a ring spanner (not shown) and having an inner periphery 4 for driving a fastener (not shown) and an outer periphery having a plurality of arcuate concave teeth 3. Referring to Fig. 12, each arcuate concave tooth 3 is formed by means of feeding a cutter 2 along a direction transverse to a radial direction (see line OR). The resultant concave tooth 3 has a depth "d" and two sides that intersect at point "R". The line OR divides the angle α defined by the two sides of the arcuate concave tooth 3 into two equal portions (usually

45° for each portion). As illustrated in Fig. 12, each arcuate concave tooth 3 is machined to have a considerable depth "d" that adversely affects the structural strength of the ratchet wheel 1, as the remaining wall thickness "t" of the ratchet wheel 1 is relatively small. As a result, the driving torque provided by the ratchet wheel for driving the fastener is limited.

Figs. 14 through 16 of the drawings illustrate a conventional ratchet wheel 5 mounted in a box end 9a (Fig. 17) of a ring spanner 9 (Fig. 17) and having an inner periphery 8 for driving a fastener (not shown) and an outer periphery having a plurality of arcuate concave teeth 6. Referring to Fig. 15, each arcuate concave tooth 6 is formed by means of feeding a cutter 7 along a radial direction. The resultant arcuate concave tooth 6 has a depth "d" and two sides that intersect at point "R". The line OR divides the angle β defined by the two sides of the concave tooth 6 into two equal portions (usually 45° for each portion). As illustrated in Fig. 15, each arcuate concave tooth 6 is machined to have a considerable depth "d" that adversely affects the structural strength of the ratchet wheel, as the remaining wall thickness "t" of the ratchet wheel 5 is relatively small. As a result, the driving torque provided by the ratchet wheel for driving the fastener is limited. Such structure has been disclosed in U.S. Patent No. 5,533,427 to Chow issued on Jul. 9, 1996, which is incorporated herein for reference. A further drawback of this conventional ratchet wheel is the low production rate for forming the arcuate concave teeth by cutting.

The present invention is intended to provide an improved ratchet wheel that mitigates and/or obviates the above problems.

Summary of the Invention

It is a primary object of the present invention to provide an improved ratchet wheel has asymmetric arcuate concave teeth for providing improved structural strength and improved torque.

It is another object of the present invention to provide an improved ratchet wheel that has non-arcuate concave teeth to allow higher production rate, as the non-arcuate concave teeth can be formed by means of roll squeezing method, investment casting, or molding. The

non-arcuate concave teeth may be symmetric or asymmetric. The ratchet wheel with non-arcuate concave teeth may bear higher torque during ratcheting (i.e., tightening or loosening a fastener).

The present invention also provides a ratcheting tool, e.g., a spanner, equipped with a ratchet wheel in accordance with the present invention. In an embodiment of the invention, the spanner has a box end for receiving a ratcheting wheel with asymmetric arcuate concave teeth. In another embodiment of the invention, the spanner has a box end for receiving a ratcheting wheel with non-arcuate asymmetric concave teeth. In a further embodiment of the invention, the spanner has a box end for receiving a ratcheting wheel with non-arcuate symmetric concave teeth.

Other objects, advantages, and novel features of the invention will become more apparent from the following detailed description when taken in conjunction with the accompanying drawings.

Brief Description of the Drawings

Fig. 1 is a perspective view of a ratchet wheel with asymmetric arcuate concave teeth in accordance with the present invention;

Fig. 2 is a side view of the ratchet wheel in accordance with the present invention;

Fig. 3 is a top view of the ratchet wheel in accordance with the present invention, illustrating formation of asymmetric arcuate concave teeth in an outer periphery of the ratchet wheel;

Fig. 4 is a top view of a box end of a ring spanner equipped with the ratchet wheel in accordance with the present invention;

Fig. 5 is a sectional view taken along line 5-5 in Fig. 4;

Fig. 6 is a top view, in an enlarged scale, of the ratchet wheel in accordance with the present invention, wherein position of symmetric concave teeth formed according to prior art is illustrated to show difference therebetween;

Fig. 7a is a perspective view of a pawl for cooperating with the asymmetric arcuate concave teeth of the ratchet wheel in accordance with the present invention;

Fig. 7b is a top view of the pawl in Fig. 7a;

Fig. 7c is a side view of the pawl in Fig. 7a;

Fig. 8a is a perspective view of a conventional pawl for cooperating with the arcuate concave teeth of the ratchet wheel in Fig. 14;

Fig. 8b is a top view of the pawl in Fig. 8a;

Fig. 8c is a side view of the pawl in Fig. 8a;

Fig. 9 is an enlarged fragmentary view illustrating operation of the pawl and the asymmetric arcuate concave teeth of the ratchet wheel in accordance with the present invention;

Fig. 10 is a schematic force diagram of the asymmetric arcuate concave tooth of the ratchet wheel in accordance with the present invention;

Fig. 11 is a perspective view of a ratchet wheel according to prior art;

Fig. 12 is a top view of the ratchet wheel in Fig. 11;

Fig. 13 is a side view of the ratchet wheel in Fig. 11;

Fig. 14 is a perspective view of another ratchet wheel according to prior art;

Fig. 15 is a top view of the ratchet wheel in Fig. 14;

Fig. 16 is a side view of the ratchet wheel in Fig. 14;

Fig. 17 is a top view of a box end of a ring spanner equipped with the ratchet wheel in Fig. 14;

Fig. 18 is an enlarged fragmentary view illustrating operation of the conventional pawl and the symmetric arcuate concave teeth of the conventional ratchet wheel in the ring spanner Fig. 17;

Fig. 19 is a schematic force diagram of the ratchet wheel in Fig. 14;

Fig. 20 is a sectional view taken along line 20-20 in Fig. 17;

Fig. 21 is a perspective view of a ratchet wheel with non-arcuate concave teeth in accordance with the present invention;

Fig. 22 is a side view of the ratchet wheel in Fig. 21;

Fig. 23 is a top view of a box end of a ring spanner equipped with the ratchet wheel in Fig 21;

Fig. 24 is a sectional view taken along line 24-24 in Fig. 23;

Fig. 25 is a top view of the ratchet wheel in Fig. 21, wherein position of symmetric concave teeth formed according to prior art is illustrated to show difference therebetween;

Fig. 26a is a perspective view of a pawl for cooperating with the non-arcuate concave teeth of the ratchet wheel in Fig. 23;

Fig. 26b is a top view of the pawl in Fig. 26a; and

Fig. 26c is a side view of the pawl in Fig. 26a.

Detailed Description of the Preferred Embodiments

Referring to Figs. 1 through 9 and initially to Figs. 1 through 3, a ratchet wheel 20 in accordance with the present invention generally includes an inner periphery 24 for driving a fastener (not shown) and an outer periphery having a plurality of arcuate concave teeth 22. Referring to Fig. 3, each arcuate concave tooth 22 is formed by means of feeding a cutter 26 along a direction transverse to a radial direction (see line OR). The resultant concave tooth 22 has a depth "d_1" and two sides RA and RB that intersect at point "R". The line OR divides the angle θ defined by the two sides RA and RB of the concave tooth 22 into two unequal portions (e.g., 30° and 60°, 40° and 50°, etc). Namely, every tooth 22 thus formed is "asymmetric", or the two sides for each teeth 22 is not equal, which is the most important feature of this embodiment of the present invention. As illustrated in Fig. 3, each concave tooth 22 is machined to have a depth "d_1" that will not adversely affect the structural strength of the ratchet wheel, as the remaining wall thickness "t_1" of the ratchet wheel 20 is still relatively large. As a result, the ratchet wheel 20 may bear a relatively large driving torque for driving the fastener.

Difference in the depth of the tooth 22 of the ratchet wheel 20 of the present invention and the depth of the tooth 6 of conventional ratchet wheel 5 (Fig. 14) is illustrated in Fig. 6. Namely, the remaining wall thickness "t_1" of the ratchet wheel 20 of the present invention is greater than the remaining wall thickness "t" of conventional ratchet wheel 5 that has the same size as the ratchet wheel 20. Referring to Figs. 4 and 17, the narrowest wall thickness (t_1 = 1.01 mm in Fig. 4 for a ratchet wheel having an outer diameter of 25.76 mm) of the ratchet wheel 20 of the present invention is almost twice as the narrowest wall thickness (t = 0.51 mm in Fig. 17 for a ratchet wheel having an outer diameter of 25.76 mm) of conventional ratchet wheel 5. Thus, the structural strength and the driving torque of the ratchet wheel of the present invention are both improved.

Referring to Fig. 4, the ratchet wheel 20 in accordance with the present invention is rotatably mounted in a box end 38 of a ring spanner 40. A web area 39 between the box end 38 and a handle 42 of the ring spanner 40 includes a compartment 36 for receiving a pawl 30. Figs. 7a through 7c illustrate the pawl 30. The pawl 30 includes a plurality of teeth 31 that are formed complimentary to the curvatures of the asymmetric arcuate concave teeth 22. An end 33 of the pawl 30 is attached to an end of an elastic member 32 the other end of which is received in a cavity 34 defined in a wall 36a defining the compartment 36, best shown in Fig. 4. Fig. 17 illustrates a conventional arrangement of a ratchet type ring spanner 9 that has a box end 9a for rotatably receiving the ratchet wheel 5. A web area (not labeled) of the ring spanner 9 includes a compartment 10 for receiving a pawl 11. Figs. 8a through 8c illustrate the pawl 11. The pawl 11 includes a plurality of teeth 11a that are formed complimentary to the curvatures of the symmetric arcuate concave teeth 6. An end (not labeled) of the pawl 11 is attached to an end of an elastic member 12 the other end of which is received in a cavity 10a defined in a wall 10b defining the compartment 10, best shown in Fig. 17. Figs. 8a, 8b, 8c, and 17 are illustrated for comparison purpose. In addition, difference in the wall thickness of the ratchet wheel 20 of the present invention and the wall thickness of conventional ratchet wheel 5 can also be clearly seen in Fig. 6 and by means of comparing Fig. 5 with Fig. 20.

In use of the ring spanner equipped with the ratchet wheel 20 in accordance with the present invention, referring to Fig. 9, the angle δ between a force N normal to the operative side P and the tangent T to the intersection I between the pawl 30 and the wall 36a defining the compartment 36 is smaller than that in the prior art ratchet wheel (see Fig. 18). As a result, the pawl 30 in Fig. 9 is reliably pushed toward the wall 36a defining the compartment 36 and thus provides a reliable engagement between the teeth 22 of the ratchet wheel 20 and the teeth 31 of the pawl 30. If the angle δ reaches 90°, the pawl moves toward the central area of the ratchet wheel and thus results in an undesired "sliding" effect, as there is no horizontal force imparted to move the pawl toward the wall 36a of the compartment 36. Thus, the ratchet wheel 20 and the pawl 30 in accordance with the present invention provides an engagement reliable than that between the conventional ratchet wheel 5 and the pawl 11 and thus less likely to "slide". The spanner with the ratchet wheel/pawl combination in accordance with the present invention can be used in a relatively small space and can be operated in a convenient manner. More specifically, the spanner is allowed to rotate in a reverse direction without disengaging the box end from the fastener when the spanner is stopped by an obstacle during ratcheting. And the spanner is then ready for next ratcheting movement. This is very convenient and timesaving.

Referring to Figs. 9 and 10, when the operative side P of the tooth 22 of the ratchet wheel 20 in accordance with the present invention is subjected to a force F during ratcheting, the area filled by the pawl 30 for bearing such force F is $2/1.732\ h^2$. Referring to Fig. 19, for a conventional ratchet wheel 5, when either operative side P of the tooth 6 of the ratchet wheel 5 is subjected to a force F, the area filled by the pawl 11 for bearing such force F is h^2 which is smaller than that provided by the ratchet wheel/pawl combination in accordance with the present invention. Namely, the ratchet wheel 20 with asymmetric arcuate concave teeth 22 provides a higher torque for ratcheting (i.e., tightening or loosening a fastener such as a nut or bolt head).

Referring to Figs. 21 and 22, in a second embodiment of the ratchet wheel in accordance with the present invention, the ratchet wheel (now designated by 50) includes an inner periphery 54 for driving a fastener (not shown) and an outer periphery having a plurality of non-arcuate concave teeth 52. The non-arcuate concave teeth 52 is formed by means of roll squeezing method, investment casting, or molding, which is quicker than formation by cutter. Each non-arcuate concave tooth 52 may be trapezoidal, triangular, or any other shape that results from formation other than cutting. The production cost for the ratchet wheel 50 with non-arcuate concave teeth 52 in accordance with the present invention is largely reduced, as the production time for the non-arcuate concave teeth 52 is relatively short. In addition, the non-arcuate concave teeth 52 may be symmetric or asymmetric. When the ratchet wheel 50 has non-arcuate symmetric concave teeth 52, the resultant structure provides a driving torque approximately the same as that provided by the conventional ratchet wheel 5 with symmetric arcuate concave teeth 6. When the ratchet wheel 50 has non-arcuate asymmetric concave teeth 52 configured similar to teeth 22, the resultant structure provides a higher driving torque than that provided by the conventional ratchet wheel 5 with symmetric arcuate concave teeth 6.

Referring to Fig. 23, the ratchet wheel 50 in accordance with the present invention may be rotatably mounted in a box end 38 0f a ring spanner 40. A web area 39 of the ring spanner 40 includes a compartment 36 for receiving a pawl 60. Figs. 26a through 26c illustrate the pawl 60. The pawl 60 includes a plurality of teeth 61 that are formed complimentary to the curvatures of the non-arcuate concave teeth 52. An end 62 of the pawl 60 is attached to an end of an elastic member 32 the other end of which is received in a cavity 34 defined in a wall 36a defining the compartment 36, best shown in Fig. 23. A detail comparison between the conventional pawl 11 illustrated in Figs. 8a through 8c, the pawl 30 of the first embodiment of the present invention illustrated in Figs. 7a through 7c, and the pawl 60 of this embodiment illustrated in Figs. 26a through 26c would be appreciated. In addition, difference in the wall thickness of the ratchet wheel 50 of the present invention and the wall thickness of

conventional ratchet wheel 5 can also be clearly seen in Fig. 25 and by means of comparing Fig. 24 with Fig. 20.

According to the above description, it is appreciated that the ratchet wheel with asymmetric arcuate concave teeth in accordance with the present invention provides a higher torque for operation and has improved structural strength as having a thicker wall in the ratchet wheel. The engagement between the ratchet wheel with asymmetric arcuate concave teeth and the pawl with asymmetric arcuate concave teeth is more reliable. The ratchet wheel with non-arcuate concave teeth in accordance with the present invention reduces the production cost for the ratchet wheel. The ratchet wheel with non-arcuate concave teeth also provides a higher torque for operation when the non-arcuate concave teeth is asymmetric. A spanner with the ratchet wheel/pawl combination in accordance with the present invention can be used in a relatively small space. Nevertheless, the ratchet wheel/pawl combination in accordance with the present invention is not limited to be used in the box end of a ring spanner. Namely, the ratchet wheel/pawl combination may be used in other ratcheting tools such as ratchet wrenches.

Although the invention has been explained in relation to its preferred embodiment, it is to be understood that many other possible modifications and variations can be made without departing from the spirit and scope of the invention as hereinafter claimed.

What is claimed is:

1. A ratchet wheel comprising an inner periphery and an outer periphery, the outer periphery including a plurality of asymmetric arcuate concave teeth each having two sides and an intersection of the two sides, the ratchet wheel including a center, a line from the center to the intersection dividing an angle between the two sides into two unequal portions.

2. A ratchet wheel comprising an inner periphery and an outer periphery, the outer periphery including a plurality of asymmetric non-arcuate concave teeth each having two sides and an intersection of the two sides, the ratchet wheel including a center, a line from the center to the intersection dividing an angle between the two sides into two unequal portions.

3. The ratchet wheel as claimed in claim 2, wherein said asymmetric non-arcuate concave teeth are not formed by cutting.

4. The ratchet wheel as claimed in claim 2, wherein said asymmetric non-arcuate concave teeth are formed by roll squeezing.

5. The ratchet wheel as claimed in claim 2, wherein said asymmetric non-arcuate concave teeth are formed by investment casting.

6. The ratchet wheel as claimed in claim 2, wherein each said asymmetric non-arcuate concave tooth is trapezoidal.

7. The ratchet wheel as claimed in claim 2, wherein each said asymmetric non-arcuate concave tooth is of a shape formed as a result of formation other than cutting.

8. A ratchet wheel comprising an inner periphery and an outer periphery, the outer periphery including a plurality of symmetric non-arcuate concave teeth each having two sides and an intersection of the two sides, the ratchet wheel including a center, a line from the center to the intersection dividing an angle between the two sides into two equal portions.

9. The ratchet wheel as claimed in claim 8, wherein said symmetric non-arcuate concave teeth are not formed by cutting.

10. The ratchet wheel as claimed in claim 8, wherein said symmetric non-arcuate concave teeth are formed by roll squeezing.

11. The ratchet wheel as claimed in claim 8, wherein said symmetric non-arcuate concave teeth are formed by investment casting.

12. The ratchet wheel as claimed in claim 8, wherein each said symmetric non-arcuate concave tooth is trapezoidal.

13. The ratchet wheel as claimed in claim 8, wherein each said symmetric non-arcuate concave tooth is of a shape formed as a result of formation other than cutting.

14. A ratcheting tool comprising:

a handle and an end connected to the handle, the end including a hole, a compartment being defined in an area between the handle and the end;

a ratchet wheel rotatably mounted in the hole of the end, the ratchet wheel comprising an inner periphery and an outer periphery, the outer periphery including a plurality of asymmetric arcuate concave teeth each having two sides and an intersection of the two sides, the ratchet wheel including a center, a line from the center to the intersection dividing an angle between the two sides into two unequal portions;

a pawl slidably mounted in the compartment and engaged with the ratchet wheel, the pawl comprising a plurality of teeth corresponding to the asymmetric arcuate concave teeth of the ratchet wheel; and

means for biasing the pawl toward a wall defining the compartment.

15. A ratcheting tool comprising:

a handle and an end connected to the handle, the end including a hole, a compartment being defined in an area between the handle and the end;

a ratchet wheel comprising an inner periphery and an outer periphery, the outer periphery including a plurality of asymmetric non-arcuate concave teeth each having two sides and an intersection of the two sides, the ratchet wheel including a center, a line from the center to the intersection dividing an angle between the two sides into two unequal portions. ;

a pawl slidably mounted in the compartment and engaged with the ratchet wheel, the pawl comprising a plurality of teeth corresponding to the asymmetric non-arcuate concave teeth of the ratchet wheel; and

means for biasing the pawl toward a wall defining the compartment.

16. The ratchet wheel as claimed in claim 15, wherein said asymmetric non-arcuate concave teeth are formed by roll squeezing.

17. The ratchet wheel as claimed in claim 15, wherein each said asymmetric non-arcuate concave tooth is of a shape formed as a result of formation other than cutting.

18. A ratcheting tool comprising:

a handle and an end connected to the handle, the end including a hole, a compartment being defined in an area between the handle and the end;

a ratchet wheel comprising an inner periphery and an outer periphery, the outer periphery including a plurality of symmetric non-arcuate concave teeth each having two sides and an intersection of the two sides, the ratchet wheel including a center, a line from the center to the intersection dividing an angle between the two sides into two equal portions;

a pawl slidably mounted in the compartment and engaged with the ratchet wheel, the pawl comprising a plurality of teeth corresponding to the symmetric non-arcuate concave teeth of the ratchet wheel; and

means for biasing the pawl toward a wall defining the compartment.

19. The ratchet wheel as claimed in claim 18, wherein said symmetric non-arcuate concave teeth are formed by roll squeezing.

20. The ratchet wheel as claimed in claim 18, wherein each said symmetric non-arcuate concave tooth is of a shape formed as a result of formation other than cutting.

Abstract of the Disclosure

A ratchet wheel includes an inner periphery and an outer periphery. The outer periphery includes a number of arcuate concave teeth each having two sides and an intersection of the two sides. The ratchet wheel includes a center, a line from the center to the intersection dividing an angle between the two sides into two unequal portions, thereby forming asymmetric arcuate concave teeth to provide improved structural strength and improved torque. In another embodiment, the concave teeth are non-arcuate to reduce the formation time for the teeth, thereby reducing the production cost.

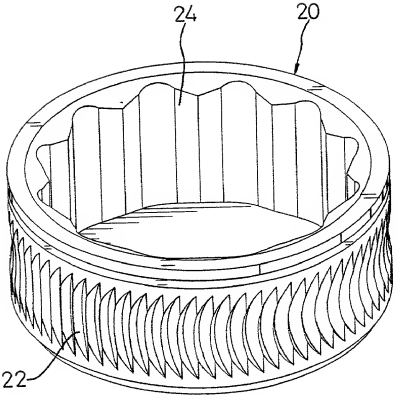


Fig. 1

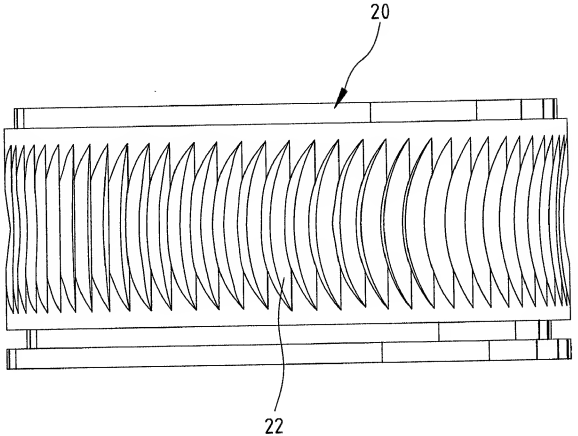


Fig. 2

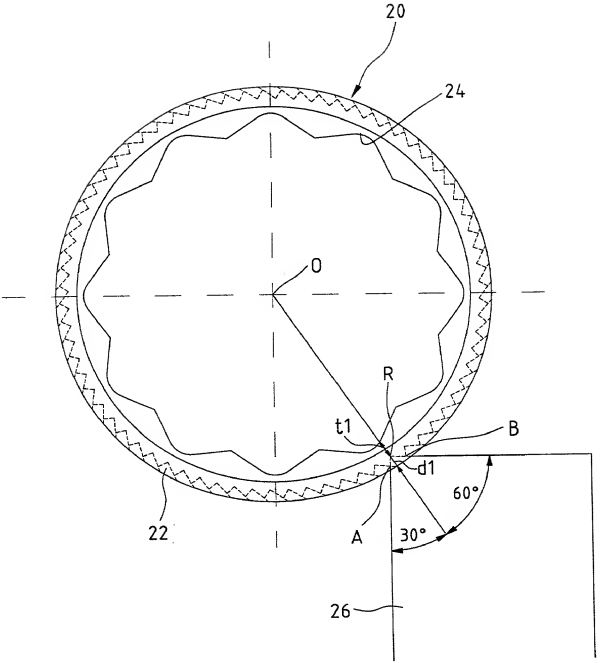


Fig. 3

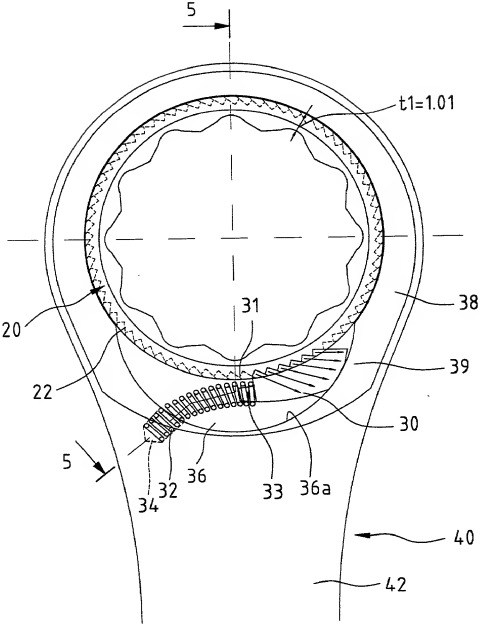


Fig. 4

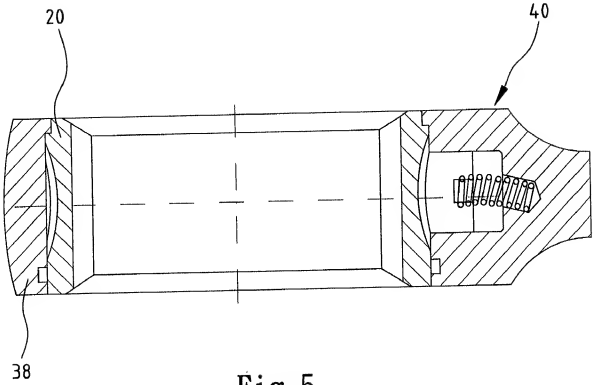


Fig. 5

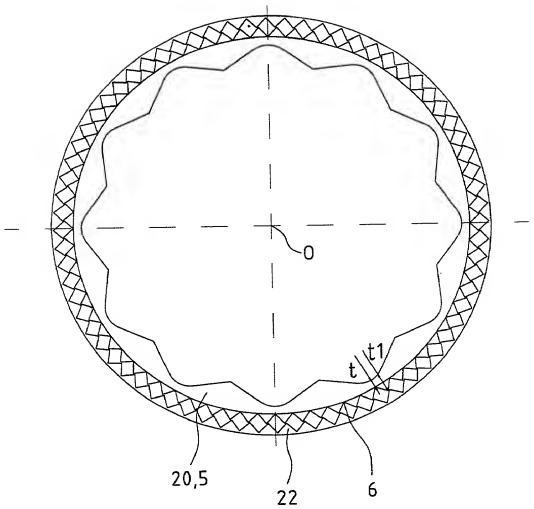


Fig. 6

Fig. 7a

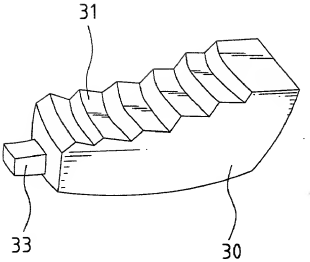


Fig. 7b

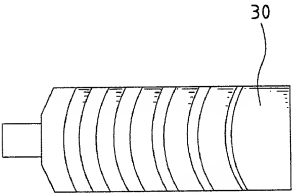


Fig. 7c

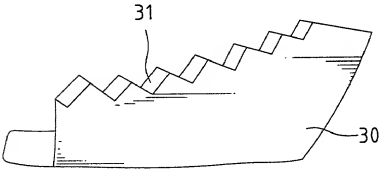


Fig. 8a
PRIOR ART

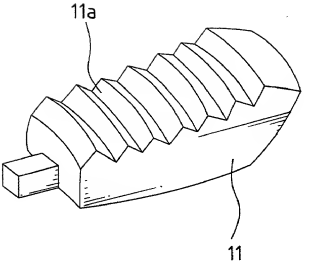


Fig. 8b
PRIOR ART

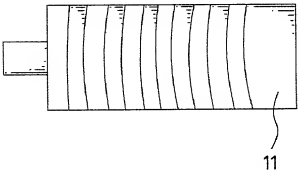
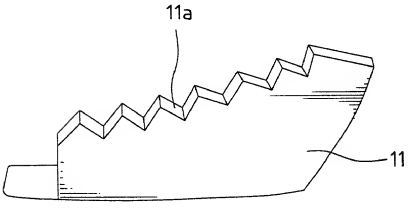


Fig. 8c
PRIOR ART



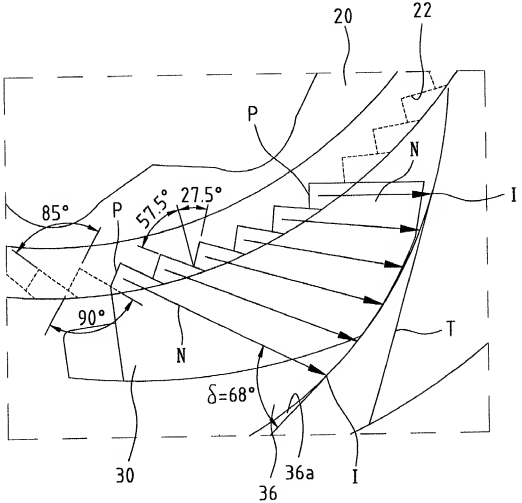


Fig. 9

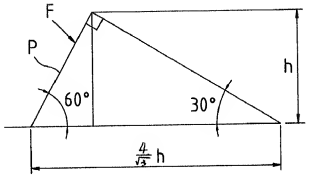


Fig. 10

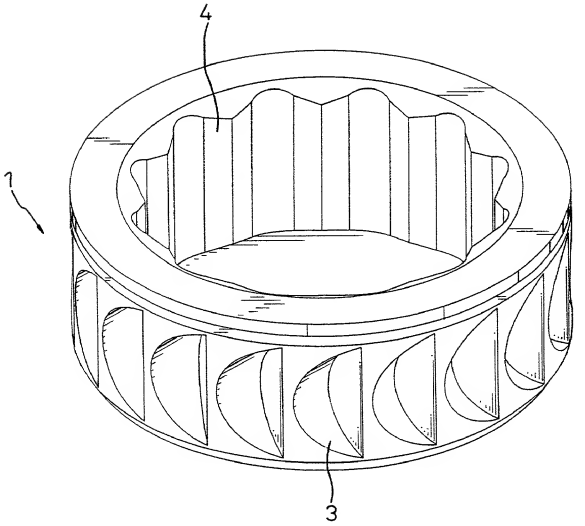


Fig. 11
PRIOR ART

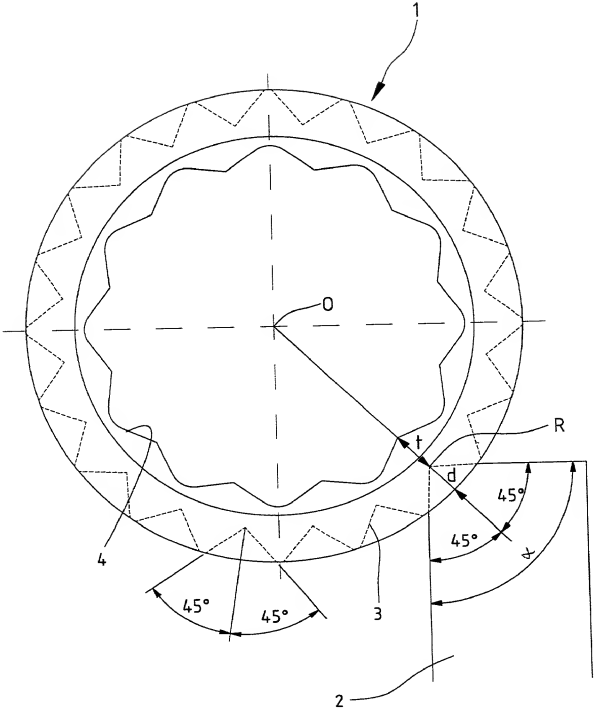


Fig. 12
PRIOR ART

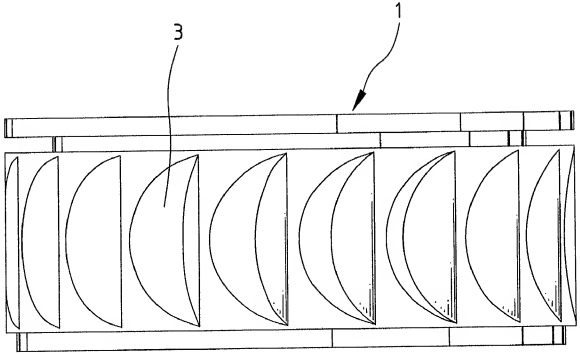


Fig. 13
PRIOR ART

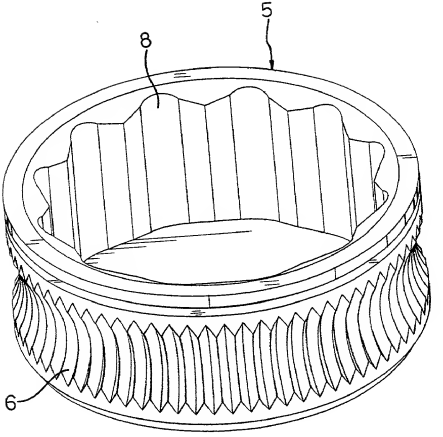


Fig. 14
PRIOR ART

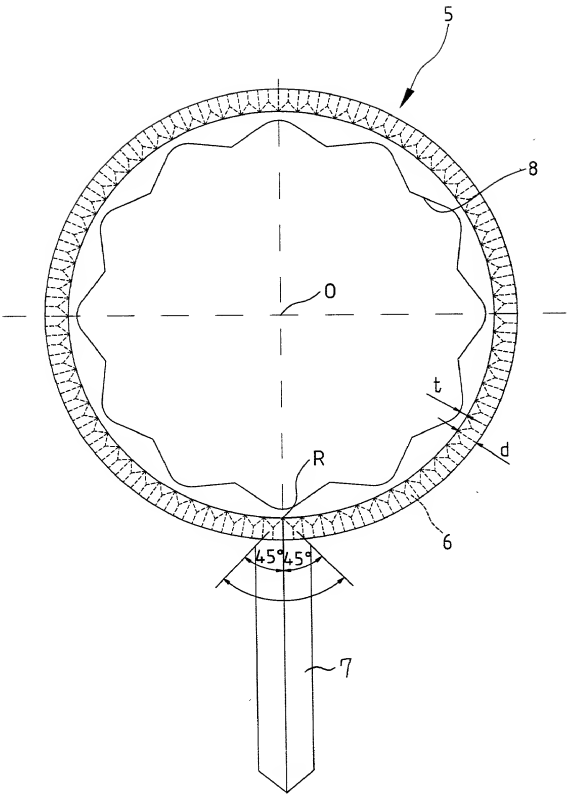


Fig. 15
PRIOR ART

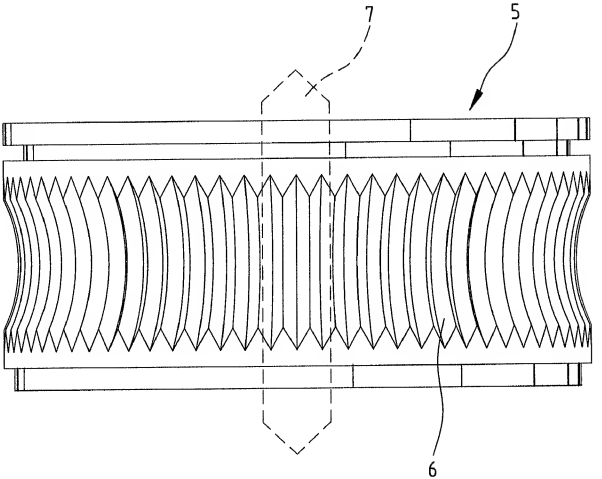


Fig. 16
PRIOR ART

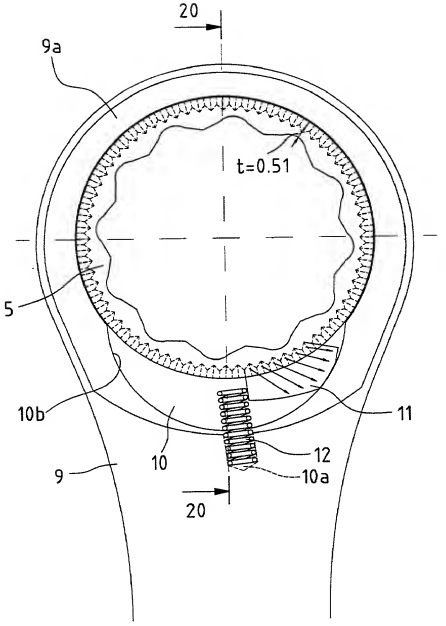


Fig. 17
PRIOR ART

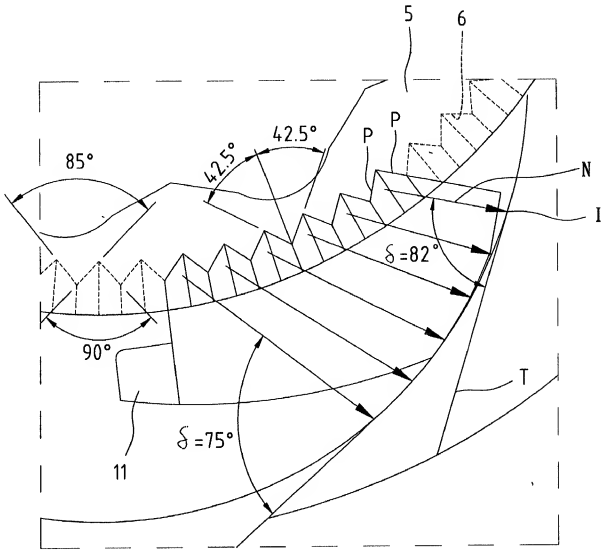


Fig. 18
PRIOR ART

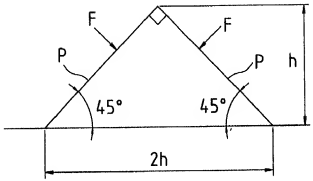


Fig. 19
PRIOR ART

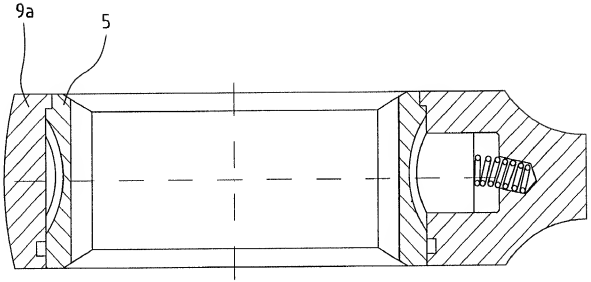


Fig. 20
PRIOR ART

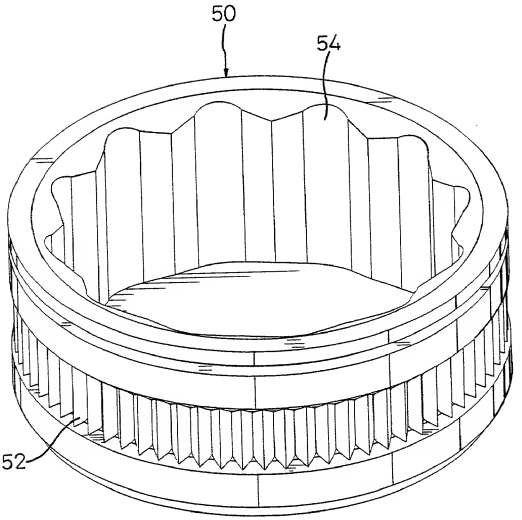


Fig. 21

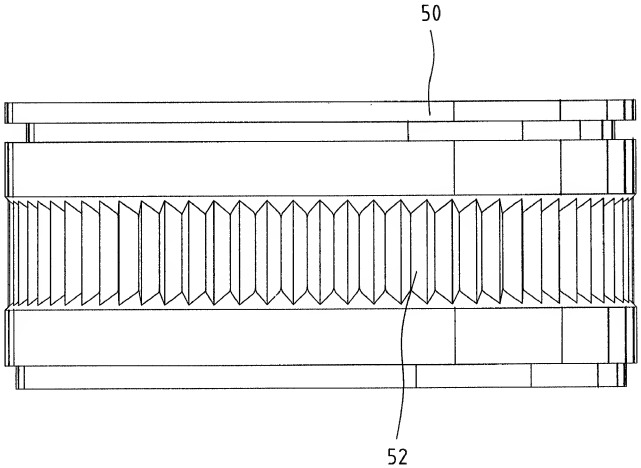


Fig. 22

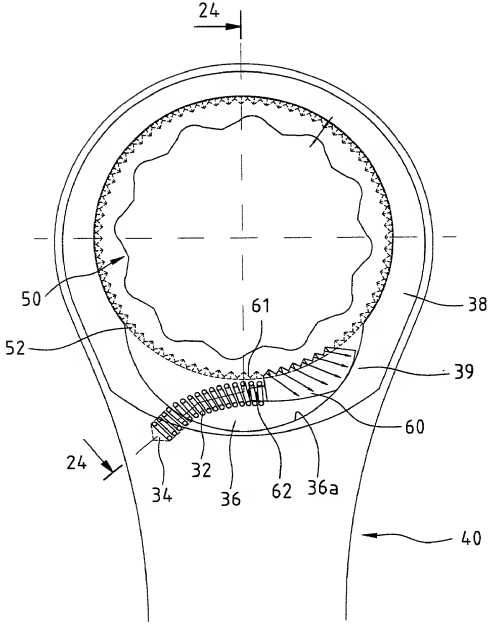


Fig. 23

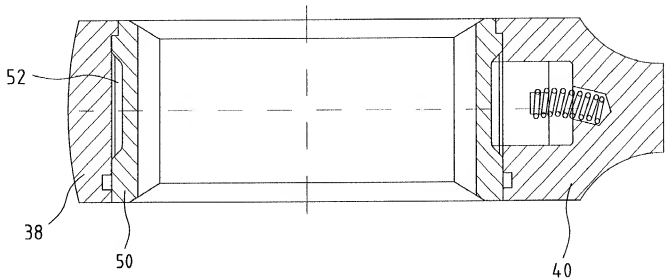


Fig. 24

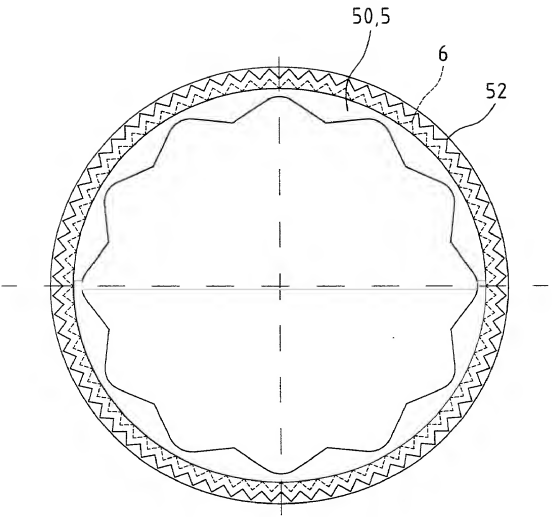


Fig. 25

Fig. 26a

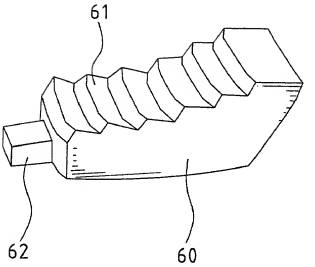


Fig. 26b

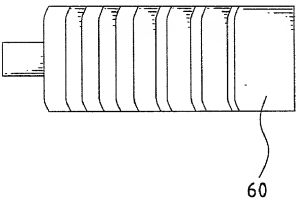
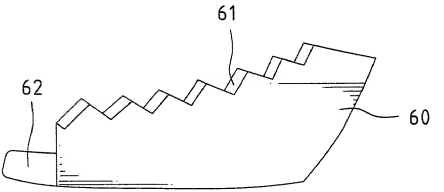


Fig. 26c



OPM No. 0651-0032 (1/31/95)

DECLARATION FOR PATENT APPLICATION

Docket No. MR2533-16

As a below named inventor, I hereby declare that:

My residence, post office address and citizenship are as stated below next to my name.

I believe I am the original, first and sole inventor (if only one name is listed below) or an original, first and joint inventor (if plural names are listed below) of the subject matter which is claimed and for which a patent is sought on the invention entitled RATCHET WHEEL WITH ASYMMETRIC ARCUATE CONCAVE TEETH OR NON-ARCUATE CONCAVE TEETH AND RATCHETING TOOLS WITH SUCH RATCHET WHEEL, the specification of which

(check one) [X] is attached hereto.
[ ] was filed on _____
as Application Serial No. _____
and was amended on _____ (if applicable).

I hereby state that I have reviewed and understand the contents of the above identified specification, including the claims, as amended by any amendment referred to above.

I acknowledge the duty to disclose information which is material to the examination of this application in accordance with Title 37, Code of Federal Regulations, § 1.56(a).

I hereby claim foreign priority benefits under Title 35, United States Code, § 119 of any foreign application(s) for patent or inventor's certificate listed below and have also identified below any foreign application for patent or inventor's certificate having a filing date before that of the application on which priority is claimed.

Prior Foreign Application(s)			Priority Claimed
(Number)	(Country)	(Day/Month/Year Filed)	☐ Yes ☐ No
(Number)	(Country)	(Day/Month/Year Filed)	☐ Yes ☐ No
(Number)	(Country)	(Day/Month/Year Filed)	☐ Yes ☐ No

I hereby claim the benefit under Title 35, United States Code, § 120 of any United States application(s) listed below and, insofar as the subject matter of each of the claims of this application is not disclosed in the prior United States application in the manner provided by the first paragraph of Title 35, United States Code, § 112, I acknowledge the duty to disclose material information as defined in Title 37, Code of Federal Regulations, § 1.56(a) which occurred between the filing date of the prior application and the national or PCT international filing date of this application.

(Application Number)	(Filing Date)	(Status – patented, pending, abandoned)
(Application Number)	(Filing Date)	(Status – patented, pending, abandoned)

I hereby appoint the following attorney(s) and/or agent(s) to prosecute this application and to transact all business in the Patent and Trademark Office connected therewith: JUN Y. LEE, ESQ., REG. #40,262
MORTON J. ROSENBERG, ESQ., REG. #26,049; DAVID I. KLEIN, REG. #33,253

Address all telephone calls to MORTON J. ROSENBERG at telephone number (410) 465-6678

Address all correspondence to ROSENBERG, MALESON & KILKER
3444 ELLICOTT CENTER DRIVE-SUITE 105
ELLICOTT CITY, MARYLAND 21043

I hereby declare that all statements made herein of my own knowledge are true and that all statements made on information and belief are believed to be true; and further that these statements were made with the knowledge that willful false statements and the like so made are punishable by fine or imprisonment, or both, under Section 1001 of Title 18 of the United States Code and that such willful false statements may jeopardize the validity of the application or any patent issued thereon.

Full name of sole or first inventor (given name, family name) BOBBY HU (HU IS FAMILY NAME)
Inventor's signature _____ Date 7/29/1999
Residence 8th Floor, Suite 1, No. 536, Da-Jian Street, Nan Twen, Taichung, Taiwan, R.O.C.
Post Office Address Same as Residence
Citizenship Taiwan, R.O.C.

Full name of second joint inventor, if any _____
Second inventor's signature _____ Date _____
Residence _____
Post Office Address _____
Citizenship _____

Applicant or Patentee: BOBBY HU

Attorney's Docket No.: MR2533-16

Serial or Patent No.: _____

Filed or Issued: _____

Title: RATCHET WHEEL WITH ASYMMETRIC ARCUATE CONCAVE TEETH OR NON-ARCUATE CONCAVE TEETH AND RATCHETING TOOLS WITH SUCH RATCHET WHEEL

VERIFIED STATEMENT (DECLARATION) CLAIMING SMALL ENTITY STATUS
(37 CFR 1.9(f) & 1.27(b))--INDEPENDENT INVENTOR

As a below named inventor, I hereby declare that I qualify as an independent inventor as defined in 37 CFR 1.9(c) for purposes of paying reduced fees to the Patent and Trademark Office regarding the invention entitled RATCHET WHEEL WITH ASYMMETRIC ARCUATE CONCAVE TEETH OR NON-ARCUATE CONCAVE TEETH AND RATCHETING TOOLS WITH SUCH RATCHET WHEEL described in:

☒ the specification filed herewith.

☐ application serial number _____, filed _____

☐ patent number _____, issued _____

I have not assigned, granted, conveyed or licensed and am under no obligation under contract or law to assign, grant, convey or license, any rights in the invention to any person who would not qualify as an independent inventor under 37 CFR 1.9(c) if that person had made the invention, or to any concern which would not qualify as a small business concern under 37 CFR 1.9(d) or a nonprofit organization under 37 CFR 1.9(e).

Each person, concern or organization to which I have assigned, granted, conveyed, or licensed or am under an obligation under contract or law to assign, grant, convey, or license any rights in the invention is listed below:*

☒ No such person, concern, or organization

☐ Persons, concerns or organizations listed below*

* Note: Separate verified statements are required from each named person, concern or organization having rights to the invention averring to their status as small entities. (37 CFR 1.27)

NAME _____

ADDRESS _____

☐ INDIVIDUAL ☐ SMALL BUSINESS CONCERN ☐ NONPROFIT ORGANIZATION

NAME _____

ADDRESS _____

☐ INDIVIDUAL ☐ SMALL BUSINESS CONCERN ☐ NONPROFIT ORGANIZATION

NAME _____

ADDRESS _____

☐ INDIVIDUAL ☐ SMALL BUSINESS CONCERN ☐ NONPROFIT ORGANIZATION

I acknowledge the duty to file, in this application or patent, notification of any change in status resulting in loss of entitlement to small entity status prior to paying, or at the time of paying, the earliest of the issue fee or any maintenance fee due after the date on which status as a small entity is no longer appropriate. (37 CFR 1.28(b))

I hereby declare that all statements made herein of my own knowledge are true and that all statements made on information and belief are believed to be true; and further that these statements were made with the knowledge that willful false statements and the like so made are punishable by fine or imprisonment, or both, under section 1001 of Title 18 of the United States Code, and that such willful false statements may jeopardize the validity of the application, any patent issuing thereon, or any patent to which this verified statement is directed.

BOBBY HU (HU IS FAMILY NAME)		
NAME OF INVENTOR	NAME OF INVENTOR	NAME OF INVENTOR
Signature of inventor	Signature of inventor	Signature of inventor
7/29/1999		
Date	Date	Date